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Similarities of the Modern Japanese and Some Asians
in Dental Size and Foodstuff Intakes

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ABSTRACT

On the basis of the among-group variations in dental size and foodstuff intakes of modern human populations, phylogenetic and environmental similarities among Asians were discussed. It has been shown that Japan is closest, in the pattern of foodstuff intakes, to Taiwan and the Philippines in the world. The pattern of foodstuff intakes and overall dental size seem to be slightly associated with each other, but neither of them is useful to trace the phylogenetic lines of modern human populations. The dental size corrected for inter-character correlations, however, seems to reflect the phylogenetic affinities of modern human populations better than the simple sum of dental measurements or the foodstuff intake patterns. The corrected dental size has revealed that Japanese is closest to Indonesians and Chinese of the continent among the Asians compared in males, but to Chinese of the continent and Indonesians in females, in the order of decreasing similarity.

It is widely known that the dental morphology of mammals such as herbivores, carnivores, etc. varies with their food habits. Even among primates, we can identify fruit eaters, leaf eaters, gum eaters, and insect eaters by observing their teeth. Such functional differentiation is, therefore, expected to be found also in the human dentition. In fact, the shoveling of incisor teeth, for example, has been considered to have a function associated with the lifeway of big-game hunting and meat-eating (Mizoguchi, 1985).

In general, each human population has each specific traditional way of life including food habit. Such a traditional lifeway has been established, partly in the same way as biological characters, through the long process of adapting themselves to the natural and sociocultural environment. Thus, the pattern of foodstuff intakes reflecting their food habit may also have some information on the establishment of the population itself. Then we may be able to utilize such data for analyzing the phylogenetic affinities of human populations to some extent. From this angle, the similarities or differences in the foodstuff intakes and tooth crown diameters between Japanese and some other populations will be discussed mainly on the basis of the recent works of Mizoguchi (1988, n.d.).

Similarity of insular East Asians in foodstuff intakes

Through a single linkage cluster analysis based on the pattern similarities in the mean intakes (kg/year·person) of nineteen foodstuffs, Tamura and Kurihara (1973) showed that 96 countries over the world could be classified into several groups. In their analysis, Japan was assigned to an Asian cluster together with Taiwan and the Philippines.

For convenience' sake, Mizoguchi (n.d.) reduced the number of the foodstuffs used by Tamura and Kurihara into four at the least loss of information by the principal component analysis. The foodstuffs selected in this way are wheat, fruits, eggs and fish, which are relatively independent of one another and can be regarded as the representatives of all the foodstuffs dealt with by Tamura and Kurihara (1973). Further, Mizoguchi (n.d.) chose the countries for which the data of the mesiodistal and buccolingual crown diameters of permanent teeth were available from literature. Eighteen countries for males and sixteen for females of the above 96 countries satisfied this condition. Using this reduced foodstuff data, Mizoguchi

(n.d.) calculated Penrose's shape distances between Japan and the other countries. The result was completely consistent with Tamura and Kurihara's one at least in the similarity of Japan to Taiwan and the Philippines. One of the characteristics of these countries, especially of Japan, is very high consumption of fish compared with the other three foodstuffs. This may be explained partly by the fact that these countries are all Asian islands surrounded by the sea. According to Mizoguchi (n.d.), the foodstuff group typified by fish contains rice, vegetables, etc. in addition to fish.

In spite of the expectation at the beginning, it has become clear that the dendrogram drawn on the basis of the Penrose's shape distances calculated from the foodstuff data hardly reflects the phylogenetic affinities of the populations (Mizoguchi, n.d.).

Correlations between foodstuff intakes and dental size

Although foodstuff intake patterns do not seem to reflect the phylogenetic interrelationships of populations, it remains possible that they have acted as one of the non-random environmental determinants of dental morphology in the course of human evolution. In order to confirm this hypothesis, Mizoguchi (1988) attempted to find some associations between the foodstuff intakes and tooth crown diameters by estimating individual product-moment correlations between them on the basis of the above Tamura and Kurihara's (1973) foodstuff data and the dental data collected from a number of previous reports. The dental data collected were of 152 male and 113 female samples obtained over the world. As a result, Mizoguchi (1988) found that the mesiodistal crown diameters of many permanent teeth were positively correlated with potatoes or the like and beef, and the buccolingual crown diameters of a considerable number of cheek teeth had negative correlations with wheat and mutton. Although the statistical significance of these correlation coefficients was not tested, Mizoguchi considered, particularly concerning the latter findings, that the small buccolingual diameters of cheek teeth might have been caused by a strong reliance on livestock because not only of the above negative correlations but also of the fact that Tibetans who have adopted the pastoral lifeway with a heavy reliance on sheep, goat and yak have buccolingually extremely small cheek teeth (Sharma, 1983).

Recently, Mizoguchi (n.d.) estimated canonical correlations between tooth crown diameters and foodstuff intakes, using the same foodstuff and much more dental data. Statistical significance was tested by Efron's (1982) bootstrap method. In result, it was found that the more the intakes of wheat and eggs are, the smaller most of the permanent teeth are. In particular, the correlation coefficient between the first canonical variates for female maxillary teeth and foodstuffs was extremely close to unity and the probability for it was 0.028. Furthermore, Mizoguchi (n.d.), using the same data as this, examined the degree of similarity between the matrices of several kinds of biological distances on tooth crown diameters and on foodstuff intakes. The degree of similarity was estimated by using Spearman's rank correlation coefficient, and the statistical significance of the coefficient was assessed through Mantel's (1967) matrix permutation test. As a result, the only rank correlation coefficient of 0.17 between the shape distance matrix on foodstuff intakes and the size distance matrix on dental size of males was significant at the 10% level. This is compatible with the results of the above canonical correlation analysis.

In sum, it is likely that the pattern of foodstuff intakes, that is, the balance and amount of

Table1. Biological distances from Japanese to other populations in the world based on tooth crown diameters and foodstuff intakes

From Japan to :	Penrose's Shape distance on food	Mahalanobis' D-square distance on teeth		Penrose's size distance on teeth	
		Male	Female	Male	Female
Morocco	4.53	9.09	14.22	0.01	0.01
Sudan	3.95	18.65	11.33	0.81	1.33
S Africa	1.97	28.57	14.86	0.06	0.08
Finland	2.43	5.50	6.21	0.02	0.02
Turkey	8.49	22.65	15.92	1.17	1.49
Israel	7.71	9.14	7.34	0.32	0.53
Afghanistan	7.44	9.79	—	0.99	—
India	3.92	17.27	9.68	0.42	1.12
China	3.13	2.95	1.46	0.04	0.03
Taiwan	1.03	9.80	4.61	0.02	0.04
Philippines	1.49	7.19	9.10	1.00	0.91
Indonesia	4.19	2.16	3.07	0.01	0.02
Australia	5.55	6.49	8.29	0.02	0.03
U.S.A.	7.75	19.92	—	0.36	—
Colombia	4.26	8.13	8.51	0.01	0.02
Surinam	1.61	10.36	11.37	0.26	0.40
Paraguay	7.78	22.04	12.49	0.49	0.19

nutrients have influenced the overall dental size of modern humans, though slightly. And, as anticipated from the above findings, the overall dental size is also unlikely to reflect the phylogenetic interrelationships of modern human populations. This is not only confirmed by the Penrose's size distances on tooth crown diameters (Table 1) but also supported by the findings of Kuragano et al. (1983) and Kieser et al. (1987) that the average size of teeth in a population can relatively easily change with the amount of calorie and protein intakes during a few decades.

Phylogenetic affinities of Asians suggested by D-square distances on teeth

As mentioned above, it was found that the overall dental size reduction was partially associated with the differential intakes of some foodstuffs such as wheat and eggs, and that, at least in modern human populations, the variation in overall dental size or foodstuff intake patterns did not appear to reflect the phylogenetic affinities. For tracing the phylogenetic lines, therefore, another procedure must be sought. Thus, after the re-examination of several biological distances on tooth crown diameters, Mizoguchi (n.d.) reconfirmed that the Mahalanobis' D-square distances calculated from skeletal or dental measurements probably reflected the phylogenetic affinities to a considerable extent. Taking account of the high correlation between Penrose's shape distance and Mahalanobis' D-square distance (Spearman's $\rho=0.90$ in males and 0.86 in females, to both of which $P < 0.01$ was assigned through Mantel's matrix permutation test; Mizoguchi, n.d.), this is also consistent with Perzigian's (1984) conclusion that Penrose's shape distance basically reflects known taxonomic, biohistoric associations.

Mizoguchi (n.d.), using D-square distances based on tooth crown diameters, found that Japanese were closest, in the order of decreasing similarity, to Indonesians and Chinese for

males, and to Chinese and Indonesians for females, but a little farther from Chinese in Taiwan and much more remote from Philippine Tagalogs, as shown in Table 1 (where it should be noted that the dental samples used for South Africa, Australia and the United States are of European immigrants). This means that the dental size corrected for inter-character correlations, not overall dental size or the simple sum of dental measurements, is similar to one another at least among Japanese, Indonesians and Chinese of the continent. The findings based on these dental size corrected for inter-character correlations are not so unreasonable in distinguishing most Asians from Africans and Europeans. But the above order in the similarity of Japanese to Indonesians and Chinese for males may be problematic in the viewpoint of Turner's (1989) Sundadonty and Sinodonty based mainly on nonmetric tooth crown characters because, according to him, Southeast Asians like Indonesians ought to have a dental variation pattern called Sundadonty and, on the other hand, East Asians such as Chinese and Japanese ought to bear another dental variation pattern called Sinodonty. Needless to say, however, the above analyses were carried out on the assumption that a grand mean calculated from many sample means obtained by different observers was a good estimate of the population mean because such sample means were, in general, considered to be normally distributed. But, in practice, the number of sample means for a population was not so large in most cases in the above Mizoguchi's (n.d.) analyses. Thus, this may be one of the causes for the above discrepancy. Although the results based on the female data supports Turner's hypothesis, this problem should further be investigated on the basis of many more data.

Conclusions

In the pattern of foodstuff intakes, Japan is closest to Taiwan and the Philippines in the world. The foodstuff intake pattern seems to have slightly influenced overall dental size or the simple sum of dental measurements, but neither of them appears to reflect the phylogenetic interrelationships of modern human populations. The dental size corrected for inter-character correlations, which seems to reflect the phylogenetic affinities to some extent, show that Japanese are closest to Indonesians and Chinese among the Asians compared.

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歯の大きさと食物摂取量における現代日本人とアジア人諸集団の類似性 溝口優司

現代人集団の歯の大きさと食物摂取量における群間変異に基づいて、アジア人諸集団間の系統および環境的類似性を考察した。

資料は歯・食物ともに文献調査によるもので、男18カ国、女16カ国の国別資料である。男の場合は、モロッコ、スーダン、南アフリカ（白人）、フィンランド、トルコ、イスラエル、アフガニスタン、インド、中国（大陸）、台湾（中国人）、日本、フィリピン、インドネシア、オーストラリア（白人）、アメリカ合衆国（白人）、コロンビア、スリナム（インド人）、パラグアイの資料、女の場合はこれらからアフガニスタンとアメリカ合衆国を除いた国々の資料である。

多変量の統計学的分析結果によれば、食物摂取パターンに関しては、日本は台湾とフィリピンに最も類似している。この類似性は、これらの国々がすべて島国であるという共通の環境条件によって一部説明されるかもしれない。食物摂取パターンは、わずかではあるが全体的な歯の大きさと相関を持っている。しかし、いずれも、現代人集団の系統を辿るためにはそれほど役立たなさそうである。

他方、形質相互相関について修正された全体的な歯の大きさは、単純な歯の計測値の合計や食物摂取パターンよりは現代人集団の系統的類縁関係をよく反映しているように思われる。こ

の修正された歯の大きさに基づいて現代人集団を分類すると、すなわち、歯の大きさに関するマハラノビスの汎距離を計算すると、日本人は、類似程度が減少する順に、男ではインドネシア人と大陸中国人に、女では逆に大陸中国人とインドネシア人に最も類似している。

以上の分析結果はまだまだ試行的なもので、今後さらに多くの資料に基づいて再検討される必要がある。